ONERA Quasi-Elliptic Wing Euler Grids

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Vassberg and Jameson's NACA0012 airfoil grid [1] of dimensions $(nc \times nc)$ cells with $nc = 256$ provide the grid of the wing symmetry plane of the basic wing grid, file *grid_256_256_128_R150.dat*. All grid dimensions are given in cell numbers, not node numbers.

The wing planform, shown in figure 1, is derived from that of a wing used in [2] for induced drag assessment. It is a truncated ellipse. Truncature avoids zero tip chord and facilitates grid generation. The tip is generated by half circles with an x-directed axis. The original wing had been designed so as to have a round number for the aspect ratio, 10. After the fitting to the closed NACA0012 airfoil of [1], it is slightly smaller.

The generating airfoil is unique and the wing is untwisted.

The basic wing grid is generated through the following procedure: first, application of the Vassberg and Jameson grid in the symmetry plane; then spanwise translation and smoothed rotation of this grid following the wing planform. The resulting grids have a monoblock O-O topology, illustrated in figure 2. Boundary $j = 1$ is the wing surface, $j = jmax = nc + 1$ the far-field boundary (roughly a half-sphere of radius approximately 150 maximum chord lengths), $i = 1$ and $i = imax = nc + 1$ the wing wake, $k = 1$ a surface in the horizontal mid-wing plane, beyond the wing tip, $k = kmax = (nc/2) + 1$ the symmetry plane.

Files *grid_256_208_128_R050.dat* and *grid_256_144_128_R010.dat* contain grids generated from restrictions of the 2D grid from dimensions (256×256) to (256×208) and (256×144) respectively. The radius of these grids is $R \simeq 50$ maximum chord lengths for *grid_256_208_128_R050.dat* and $R \simeq 10$ for *grid_256_144_128_R010.dat*.

The data format is Tecplot ASCII BLOCK.

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These grids are part of those used in [3]. In this reference, the conventional way of computing wing aspect ratio and grid radius is described in Appendix B. Computations in [3] are performed with conditions $M_\infty = 0.20, \alpha = 6.00°$ and comparisons at given $CL_p = 0.58$ are done assuming that the induced drag coefficient varies as the square of the lift coefficient.

References

[1] Vassberg, J. C. and Jameson, A., "In Pursuit of Grid Convergence for Two-Dimensional Euler Solutions," *Journal of Aircraft*, Vol. 47, No. 4, July-August 2010, pp.1152-1166.

[2] Destarac, D., "Far-Field / Near-Field Drag Balance and Applications of Drag Extraction in CFD," VKI Lecture Series 2003, *CFD-based Aircraft Drag Prediction and Reduction*, von Karman Institute for Fluid Dynamics, Rhode Saint Genèse, February 3-7, 2003, National Institute of Aerospace, Hampton (VA), November 3-7, 2003.

[3] Destarac, D., "A Three-Component Breakdown of Spurious Pressure Drag in Computational Fluid Dynamics," to appear in *Journal of Aircraft*.

Figures

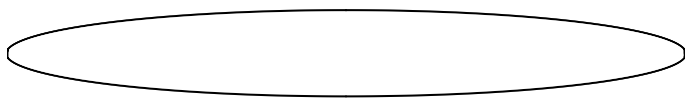

Fig. 1 Planar wing with a truncated ellipse planform ("quasi-elliptic wing").

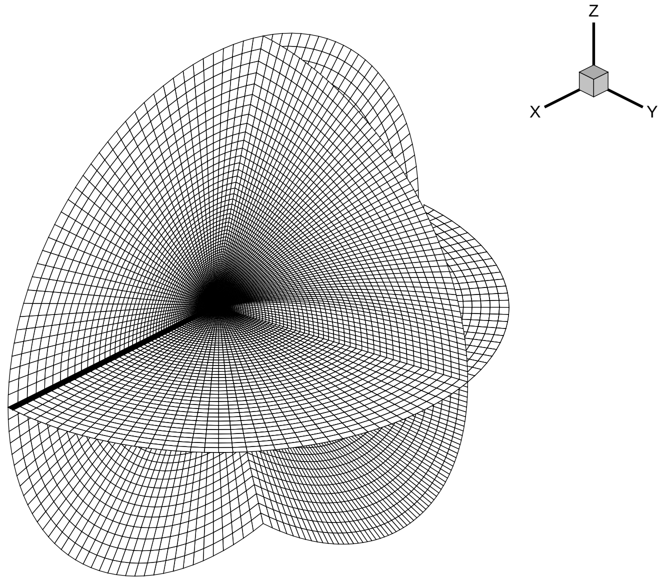

Fig. 2 Monoblock O-O wing grid topology

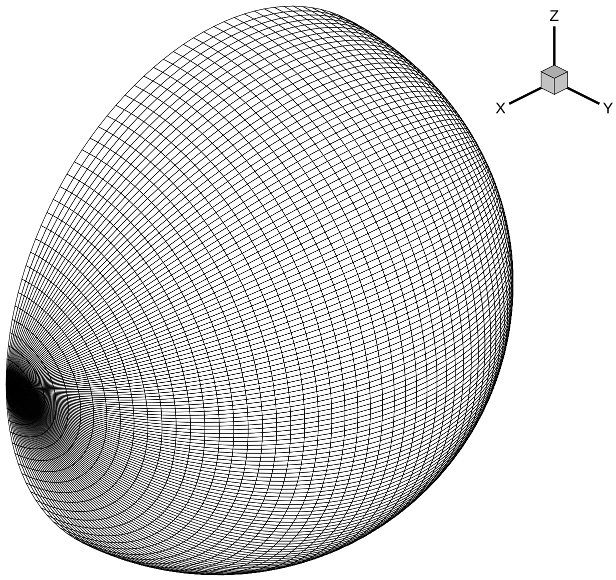

Fig. 3 Outer boundary of O-O type $128 \times 128 \times 64$ wing grid based on Vassberg and Jameson's NACA0012 airfoil grid